

Designing an agricultural mobile application for a rural community using HCI principles

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CHAPTER 1: INTRODUCTION

1.1 Introduction and background

The goal of this study is to design an agricultural mobile application for a rural community by determining which HCI (Human-Computer Interaction) principles are appropriate design guidelines. The mobile application will be used in farming communities' decision making process.

Agricultural activities play a big role in the South African economy. It is estimated that around 8.5 million people in South Africa receive an agriculturally related income (SouthAfrica.info, 2012). The farming industry continues to be a growing industry. According to Statistics South Africa (2016), the gross income for farming in 2011 was R131.5 billion and in 2012 that number increased to R147.4 billion.

Some farmer's struggle to produce profitable crops. Farming techniques are usually tried and tested through generational use. According to Maltz (2012), farming knowledge disintegrates with each passing generation. Rudolph (2015) states that mobile application usage has increased by 21% in 2014. She further suggests that the growing profits from mobile applications can be seen as an indicator of its prominence in the future. From the statements above, one way to prevent the deterioration of knowledge is to design a mobile application that can house all the required information on crops: a farming reference manual.

This chapter begins with an explanation on the theoretical concepts applicable to the study in Section 1.2. Section 1.3 introduces the research problem for the study. The objectives are formulated in Section 1.4. An overview of the research methodology is given in Section 1.5. The participants of the study are introduced in Section 1.6. The ethical considerations are noted in Section 1.7. This chapter ends with a framework of the chapter classification in Section 1.8.

1.2 Theoretical concepts

This sections aids in explaining the key concepts used in the study.

1.2.1 Human-Computer Interaction

Human-Computer Interaction (HCI) is a broad discipline that focuses on the design, construction and implementation of interactive computer structures (Beal, 2016). According to Dix (2009), HCI is the study of how computer technology influences the way we do activities. Smith-Atakan (2006) states that HCI helps in gaining a competitive advantage in the growing Information and Communications Technology (ICT) sector. HCI also allows for the identification of designs and design processes that people require to simplify life.

1.2.2 HCI principles

HCI principles are the design principles that will be used in the study within the field of HCI. These principles can be seen as guidelines that stipulates the design process (Rogers *et al.*, 2011:20).

1.2.3 Mobile applications

Mobile applications are software programs that are produced to run on small computing devices. Mobile applications are designed to work on smartphones or tablets. Mobile application usage range from entertainment to transactional (Rouse, 2013). Mobile applications are divided into three categories. According to Montecuolo (2011), the first mobile application category is web-based as a mobile application can be hosted from a website and accessed through a mobile device browser. Montecuolo (2011) further explains that the second mobile application category is a native mobile application, which is an application that is built for a specific platform. The third category is a hybrid application as this type of application has the features of the first two types of applications (Rouse, 2013).

1.2.4 Knowledge management in agriculture

Knowledge management is the gathering and distributing of information for an intended use (Koenig, 2012). Agriculture is the practice of farming which includes activities such as cultivating the land and the process of growing crops (New English Usage Dictionary, 1996:16). Agricultural communities produce crops and care for domesticated livestock. According to the Department of Agriculture, Forestry and Fisheries (2015), the gross farming income for the year 2014 was two hundred and fifteen billion, one hundred and thirty five million rand (R215 135 000 000), which was 13.2% higher than the previous year. Knowledge management in agriculture allows farmers to access agricultural knowledge and yield value from the knowledge resources (Lwoga, 2011).

1.2.5 Design science research

According to Weber (2010), design science research can be seen as a research approach that intends to practically solve problems. Vaishnavi and Kuechler (2004) state that design science research can be defined as the creation of artefacts to fulfil a predetermined set of requirements.

By having explained the key concepts used in the study the research problem can be introduced.

1.3 Research problem

Agricultural communities are finding it difficult to keep up with new regulations (Western Farm Press, 2011). Generational knowledge is not being passed down and new and developing farmers

are not able to access the generational knowledge. Rural communities find it difficult to keep up with modern farming trends and techniques (Sun, 2014).

According to Campbell (1990:9), domesticated animals such as oxen and mules were used to cultivate the fields. From the 1990s, there are a variety of machinery that perform the same activities in a fraction of the time (Campbell, 1990:2). Hence, the use of technology in agricultural activities is not a new concept to farmers.

The use of mobile applications could be the next technological step. Mobile applications are becoming more prominent in the current generation as the average time spent on a mobile application has increased by 21% in 2014 (Rudolph, 2015). Since mobile applications are used to improve the way of life, it could also be used to improve the way of farming. In order to create a useful agricultural mobile application artefact the relevant design rules, or HCI principles, should be researched.

1.4 Research objectives

The study is aimed at designing an agricultural mobile application that will be used by a rural community by determining which HCI principles are appropriate. The following are the research objectives that are applicable to the study:

1.4.1 Primary objective

To design an agricultural mobile application for a rural community by determining which HCI principles are appropriate design guidelines.

1.4.2 Secondary objectives

The secondary objectives are categorised into theoretical and empirical objectives.

- **Theoretical objectives**

- » Develop an understanding of HCI.
- » Understand HCI principles.
- » Gain knowledge of design science research.
- » Research HCI principles that are appropriate for mobile application design.
- » Research the need for mobile applications within the field of agriculture.

- **Empirical objectives**

- » Conduct interviews with specialists.
- » Analyse data gathered in interviews.
- » Design a mobile application for a rural community using HCI principles.

The next section introduces the research methodology used in the study.

1.5 Research methodology

Research methodology can be defined as the study of methods through which researchers gain knowledge (Rajasekar *et al.*, 2013). For the purpose of this study, the applicable research methodology is design science research.

According to Weber (2010), design science research is rooted from the engineering discipline as it involves creating a human-centric artefact. Design science is both a product and a process (Hevner *et al.*, 2004:78). Peffers *et al.* (2007) summarises design science research as designing objects with embedded solutions for an identified research problem.

Lazar (2010:180) states that HCI researchers prefer to use interviews and focus groups as data gathering techniques. Lazar (2010:180) further states that interviews in a HCI study can be conducted during any phase of a study. For the purpose of this study, written interviews will be conducted to gather requirements for the design of a mobile application prior to the development phase. The participants who will take part in the written interviews are identified in the next section.

1.6 Participants

The participants applicable to this study are specialists in the fields of mobile application and HCI. Mobile application specialists will be able to suggest design requirements in terms of mobile application usability. HCI experts can suggest design specifications according to the applicable HCI principles. The written interviews will be conducted before the design of an artefact. Written interviews will be conducted with these specialists until the saturation of information is achieved.

The ethics that will be followed throughout the study are discussed in the next section.

1.7 Ethical considerations

According to Driscoll and Brizee (2012), some ethical considerations to consider when conducting a study are:

- To make sure that permission is obtained from all participants (See Appendix A).
- To not do something that can create emotional or physical harm to participants.

- To make sure that your own biased opinions do not interfere with the study.
- To inform all participants on whether they will stay anonymous or not.
- To use participants that are beneficial to the study.
- To make sure that the research is accurate.

In addition to the above mentioned ethical considerations, the ethical considerations below must also be adhered to:

- Review the short form for ethical clearance at NWU (North-West University) (See Appendix B).
- Get approval from the ethics committee at NWU to collect data from participants (See Appendix C).

The layout of the study is explained in the following section.

1.8 Chapter classification

This study will be comprised of the following chapters:

Chapter 1: Introduction - This chapter introduced the underlying problem in which the research will be conducted. The methodology which will be followed and the participants that will participate were briefly explained. The objectives were formulated. The applicable ethical considerations were noted.

Chapter 2: Research methodology - This chapter will explain the research paradigm applicable to the study. It will also further elaborate on the use of design science as the chosen research methodology.

Chapter 3: Literature review - This chapter will provide a discussion on existing literature and will elaborate on the key concepts of the study.

Chapter 4: Data analysis - This chapter will discuss the data gathering technique to be used in the study and how the data will be analysed.

Chapter 5: The artefact design - This chapter will serve to display the mobile application artefact that integrates the HCI principles used.

Chapter 6: Conclusion - This chapter will provide an overview of the study and will conclude the study.

1.9 Conclusion

This chapter served as an introduction to the design of an agricultural mobile application using principles of human-computer interaction. The objectives of the study were formulated and the participants were identified. Since the research problem was identified as the loss of agricultural knowledge, a mobile application that assists in making farming decisions can be seen as a possible solution.

The next chapter discusses the literature on the research methodology and introduces design science research as the applicable research methodology for the study.

CHAPTER 2: RESEARCH METHODOLOGY

2.1 Introduction

The goal of this study is to design an agricultural mobile application for a rural community by determining which HCI principles are appropriate design guidelines. In order to achieve this, the researcher must conduct research on the appropriate research methodologies.

Research is the logical and systematic analysis of new and existing facts in order to develop new knowledge (Rajasekar *et al.*, 2013). Kothari (2004:8) defines research methodology as an approach taken to solve a research problem. This chapter focuses on the research methodology and the role the research methodology has on the study.

This chapter begins with a discussion on the research process (Section 2.2). Section 2.3 continues with introducing the research paradigms, which is followed by an overview of design science research in Section 2.4. Section 2.5 focusses on the research problem and the research objectives. The data gathering techniques and participants are elaborated on in Section 2.6. The data analysis method is explained in Section 2.7 and an explanation of the ethics applicable to the study is given in Section 2.8. Section 2.9 concludes the chapter with an overall summary of the literature gathered.

2.2 Research process

The research process is the foundation on which skills are used in order to locate information that is beneficial to the study (Miguel de Benavides Library, 2008). From a broader definition, a research process is the steps taken to conduct research and meet objectives.

The research process that will be followed in this study is derived from the publication schema for a design science study as suggested by Gregor and Hevner (2013) and is portrayed in Table 2.1. The study begins with an introduction in which the research problem is identified and the research objectives are formulated. The literature review includes research on existing mobile applications and human-computer interaction. The methodology applicable to the study is design science research as the primary objective of the study is to design an agricultural mobile application for a rural community by identifying the relevant HCI principles as design guidelines. A mobile application that is easy to understand and allows the user ease of access to information is the artefact description. The evaluation and conclusion of the artefact is dependent on whether the suggestions made in the written interviews were implemented in the development phase. The discussions will occur between the researcher and participants.

Table 2.1: Publication schema for a design science research study (Gregor & Hevner, 2013).

Section	Contents
1. Introduction	<p><i>Problem definition, problem significance/motivation, introduction to key concepts, research questions/objectives, scope of study, overview of methods and findings, theoretical and practical significance, structure of remainder of paper.</i></p> <p>For DSR, the contents are similar, but the problem definition and research objectives should specify the goals that are required of the artefact to be developed.</p>
2. Literature Review	<p><i>Prior work that is relevant to the study, including theories, empirical research studies and findings/reports from practise.</i></p> <p>For DSR work, the prior literature surveyed should include any prior design theory/knowledge relating to the class of problems to be addressed, including artefacts that have already been developed to solve similar problems.</p>
3. Method	<p><i>The research approach that was employed.</i></p> <p>For DSR work, the specific DSR approach adopted should be explained with reference to existing authorities.</p>
4. Artefact Description	<p><i>A concise description of the artefact at the appropriate level of abstraction to make a new contribution to the knowledge base.</i></p> <p>This section (or sections) should occupy the major part of the paper. The format is likely to be variable but should include at least the description of the designed artefact and, perhaps, the design search process.</p>
5. Evaluation	<p><i>Evidence that the artefact is useful.</i></p> <p>The artefact is evaluated to demonstrate its worth with evidence addressing criteria such as validity, utility, quality, and efficacy.</p>
6. Discussion	<p><i>Interpretation of the results: what the results mean and how they relate back to the objectives stated in the Introduction section. Can include: summary of what was learned, comparison with prior work, limitations, theoretical significance, practical significance, and areas requiring further work.</i></p>

	Research contributions are highlighted and the broad implications of the paper's results to research and practise and discussed.
7. Conclusion	<p><i>Concluding paragraphs that restate the important findings of the work.</i></p> <p>Restates the main ideas in the contribution and why they are important.</p>

Before the research methodology best suited for the purpose of this study can be selected, it is necessary to understand the research paradigm that the study falls within.

2.3 Research paradigms

A paradigm is a view of reality that is based on a set of concepts, assumptions, practices and values (McGregor & Murnane, 2010). Vaishnavi and Kuechler (2004) identify three philosophical paradigms (positivistic, interpretive and design) each of which has four philosophical assumptions namely: Ontological, Epistemological, methodological and axiological.

Ontological assumptions describe the nature of being whereas epistemological assumptions are related to the nature of knowledge (King & Kimball, 2004; Vaishnavi & Kuechler, 2004). According to Rahmawati (2008), methodological assumptions are concerned with the methods used to capture data. Axiological assumptions depict the values that are applicable to the study (Vaishnavi & Kuechler, 2004). Table 2.2 depicts the philosophical assumptions of each research paradigm.

Table 2.2: Research perspectives with philosophical assumptions (Vaishnavi & Kuechler, 2004).

Basic Belief	Research Perspective		
	Positivist	Interpretive	Design
Ontology	A single reality. Knowable, probabilistic.	Multiple realities, socially constructed.	Multiple, contextually situated alternative world-states. Socio-technologically enabled.
Epistemology	Objective; dispassionate.	Subjective, i.e. values and knowledge emerge	Knowing through making: objectively constrained construction within a context. Iterative

	Detached observer of truth.	from the researcher-participant interaction.	circumscription reveals meaning.
Methodology	Observation; quantitative, statistical.	Participation; qualitative. Hermeneutical, dialectical.	Developmental. Measure artefactual impacts on the composite system.
Axiology: what is of value	Truth: universal and beautiful; prediction.	Understanding: situated and description.	Control; creation; progress (i.e. improvement); understanding.

According to Vaishnavi and Kuechler (2004), the three identified research paradigms are positivist, interpretive and design science. Although critical research is not presented in the table above, it can also be identified as a research paradigm (Baskerville, 2008:442). The research paradigms will shortly be discussed in the section below.

In the *positivist research* paradigm, researchers use quantitative methods to conduct the study and remain objective to that study (Cohen & Crabtree, 2006). According to Mack (2010), the positivist paradigm can also be seen as the scientific paradigm.

The *interpretive research* paradigm was constructed as a reaction to the positivistic paradigm (Mack, 2010). Mack (2010) further explains that the interpretive paradigm focuses on the researcher's ability to build meaning from the study. Qualitative methods are used in interpretive research (Cohen & Crabtree, 2006).

The *design science research* paradigm involves developing an artefact for an identified problem (Peppers *et al.*, 2007). The design science researcher expands the meaning of information through the process of development (Vaishnavi & Kuechler, 2004).

The *critical research* paradigm can be seen as a paradigm of transformation and emancipation (Ponterotto, 2005). Richardson and Robertson (2007) define critical research as a combination of theory and action as the aim of this paradigm is to improve the current research situation.

Design science research was found to be the most appropriate paradigm for the purpose of this study. The study is aimed at identifying the most relevant HCI principles to use in the development of an agricultural mobile application artefact. Researchers in design science research are required

to make a verifiable contribution to the development and evaluation of an artefact (Peffers *et al.*, 2007). In order to evaluate the artefact, qualitative methods for data collection will be used.

Design science research and its suitability will be elaborated on in the following section.

2.4 Design science research

Design science is knowledge in the form of methods and techniques for creating artefacts that are intended for a specific purpose (Vaishnavi & Kuechler, 2004). Simon (1996:114) suggests that design is concerned with how things should be whilst developing artefacts to achieve certain requirements.

The design science research framework that this study will follow is illustrated in Figure 2.1 below.

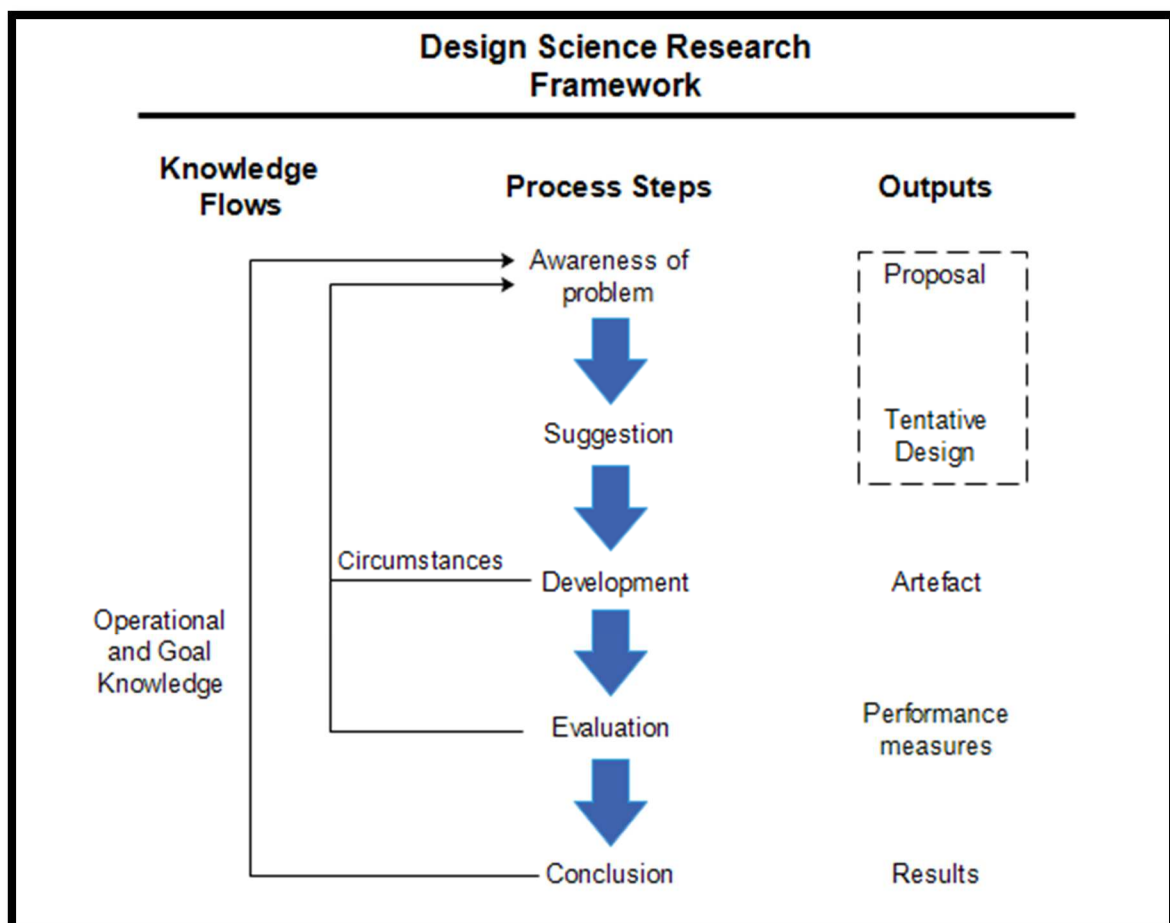


Figure 2.1: Design science research framework (Vaishnavi & Kuechler, 2004; Hevner & Chatterjee, 2010:27).

The design science research framework consists of five phases namely: awareness of problem, suggestion, development, evaluation and conclusion.

1. *Awareness of problem* – This phase involves the identification of a problem by the researcher. This problem becomes the focus objective of the study.

The problem that initiated this study was the lack of support systems that help rural agricultural communities.

2. *Suggestion* – In this phase, a solution to the problem identified is suggested. This phase assists in connecting the lines between the identification of a problem and the solution thereof.

In the case of this study, HCI principles will be identified in order to design an agricultural mobile application and written interviews will be conducted with specialists as part of a requirements analysis.

3. *Development* – This phase involves the development of the suggested solution given by the researcher.

In this phase, a mobile application will be designed according to the relevant HCI principles identified as well as the feedback obtained from the written interviews.

4. *Evaluation* – In this phase, the designed artefact is assessed and evaluated through interpretive methods.

In this phase, the mobile application will be evaluated by comparing the design of the artefact to the research conducted and feedback gathered in the suggestion phase.

5. *Conclusion* – In this phase, the research is officially completed and a satisfactory artefact is presented.

With regards to this study, the design of artefact will conclude if it meets the requirements gathered in the suggestion phase.

During the development and evaluation phases, new problems and solutions can present themselves. This means that the five phase process becomes iterative. The process will conclude when the artefact adheres to the suggestions given by the participants as well as the HCI principles identified as appropriate design guidelines. The research guidelines, as set out by Hevner *et al.* (2004:83), will be used in the design of the artefact. These guidelines are tabulated in Table 2.3 below.

Table 2.3: Design science research guidelines (Hevner *et al.*, 2004:83).

Guideline	Description
Guideline 1: Design as an Artefact	Design science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artefact. Design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.
Guideline 6: Design as a Search Process	The search for an effective artefact requires utilising available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

By having identified design science research as the most relevant methodology for the purpose of the study, the research problems and objectives can be presented according to the five phases of DSR.

2.5 Research problem and objectives

The research problem is explained in the next section followed by the formulation of research objectives.

2.5.1 Research problem

Agricultural communities are finding it difficult to keep up with new regulations (Western Farm Press, 2011). Generational knowledge is not being passed down and new and developing farmers are not able to access the generational knowledge. Rural communities find it difficult to keep up with modern farming trends and techniques (Sun, 2014).

According to Campbell (1990:9), domesticated animals such as oxen and mules were used to cultivate the fields. From the 1990s, there are a variety of machinery that perform the same activities in a fraction of the time (Campbell, 1990:2). Hence, the use of technology in agricultural activities is not a new concept to farmers.

The use of mobile applications could be the next technological step. Mobile applications are becoming more prominent in the current generation as the average time spent on a mobile application has increased by 21% in 2014 (Rudolph, 2015). Since mobile applications are used to improve the way of life, it could also be used to improve the way of farming. In order to create a useful agricultural mobile application artefact the relevant design rules, or HCI principles, should be researched.

2.5.2 Research objectives

An objective is a result that a system or person wants to achieve within in certain time frame (BusinessDictionary.com, 2016). From the aforementioned statement one can say that a research objective is thus a specific result that a person would want to achieve within a certain time frame for an intended study.

The research objectives were introduced in Section 1.4. Below are the research objectives in terms of the design science research framework.

1. Phase 1: Awareness of problem

- Theoretical objectives:
 - » To understand the concept of Human-Computer Interaction (HCI);
 - » To understand the concept of HCI principles as design rules;
 - » To gain knowledge on design science research.

2. Phase 2: Suggestion

- Theoretical objective:
 - » To form a link between HCI principles and mobile application principles.
- Empirical objectives:
 - » To conduct interviews with participants;
 - » To analyse feedback gathered in interviews.

3. Phase 3: Development

- Empirical objective:
 - » To design a mobile application according to HCI principles, mobile application principles and the analysed data.

4. Phase 4: Evaluation

- Empirical objective:
 - » To evaluate whether the mobile application designed in the development phase meets the requirements identified in the suggestion phase.

5. Phase 5: Conclusion

- Theoretical objective:
 - » To report on the mobile application principles used for the design of a mobile application for an agricultural community as well as the HCI principles used.

Through analyses of the research problem and objectives the data gathering techniques and applicable participants can be explored.

2.6 Data gathering techniques and participants

According to Rogers *et al.* (2011:234), numerous data gathering techniques are used to analyse and interpret data in academic research. He further states that the most common techniques available to researchers are: interviews, questionnaires, observations and documents. These data gathering techniques are defined as follows:

- An *interview* is a special kind of conversation between people where one person has the intent of gaining information from the other (Oates, 2006:186). A written interview is an interview that is not conducted orally.
- A *questionnaire* is a data gathering technique that includes a sequence of questions aimed at drawing information from the participant (Rogers *et al.*, 2011: 211).
- *Observation* is the process of studying people in their own environment in order to gain insight into their behaviour (MacDonald & Headlam, 2008:50).
- *Documents* are manuals that include procedures and rules for a specific task (Rogers *et al.*, 2011: 214).

According to Rogers *et al.* (2011: 211), an interview is a process where someone is asked a set of questions. An interview is a direct conversation with a question and answer format (Kendall & Kendall, 2011:103). The data gathering technique to be used in this study is written interviews. The written interviews will be conducted with specialists in the fields of mobile application and

HCI in order to gather requirements for the design of an agricultural mobile application. The analysis method of the gathered data is explained in the next section.

2.7 Results of data analysis

The data gathered for the design of the mobile application artefact will be analysed by the researcher. The analysis and feedback will be taken into consideration for the design of the artefact.

Schultze and Avital (2011:15) state that interviews in the information systems research field benefit from generating rich data. Using rich data will require the use of content analysis. According to Marsh and White (2006), content analysis is when the research makes valid inferences from text. As a process for content analysis, Corbin and Strauss (1990) describe open coding as an interpretive process. Data is broken down into smaller parts for closer examination into its similarities and differences (Corbin & Strauss, 1990). For the purpose of this study, open coding will be used to analyse the results of the gathered data. The ethics that will be considered throughout the study is discussed in the next section.

2.8 Ethical considerations

According to Driscoll and Brizee (2012), some ethical considerations to consider when doing a study are:

- To make sure that permission is obtained from all participants (See Appendix A).
- To not do something that can create emotional or physical harm to participants.
- To make sure that your own biased opinions do not interfere with the study.
- To inform all participants on whether they will stay anonymous or not.
- To use participants that are beneficial to the study.
- To make sure that the research is accurate.

In addition to the above mentioned ethical considerations, the ethical considerations below must also be adhered to:

- Review the short form for ethical clearance at NWU (North-West University) (See Appendix B).
- Get approval from the ethics committee at NWU to collect data from participants (See Appendix C).

2.9 Conclusion

The focus of this chapter was the research methodology applicable to this study. Design science research was identified to be the relevant methodology as the objective of this study is to design a mobile application artefact by identifying the relevant HCI principles. The research paradigms and research process were elaborated on. The design science research framework was introduced and the objectives were formulated according to this framework.

The next chapter introduces a detailed literature review of HCI principles, mobile applications and the appropriate application of HCI principles.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

The goal of this study is to design an agricultural mobile application for a rural community by determining which HCI principles are appropriate design guidelines. In order to achieve this, the researcher must conduct research on existing literature on the key concepts of the study.

Literature review, as defined by Fink (2014:3), is a systematic and unambiguous way of identifying and evaluating existing bodies of completed work. A literature review assists in creating a secure foundation for advancing knowledge (Webster & Watson, 2002). Ridley (2002:6) further elaborates on the importance of a literature review by stating that a literature review provides a bigger picture in which the background is explained and the research path is paved ahead. From the statements above, the researcher can conclude that by conducting a literature review the researcher gains further insight into the research field.

This chapter begins with a discussion on the electronic tools that are appropriate for agricultural education (Section 3.2). Section 3.3 introduces mobile applications for agricultural learning. Human-Computer Interaction is explained in Section 3.4 followed by a discussion on the HCI principles relevant to mobile application design in Section 3.5. Section 3.6 concludes the chapter.

3.2 Electronic tools appropriate for agricultural learning and knowledge management

Agricultural learning can be defined as the teaching of various aspects relating to agricultural activities (Costopoulou *et al.*, 2010). According to Mtega *et al.* (2014), in order to improve agricultural production, effective information should be available as information is key in helping farmers make productive decisions. Lwoga (2011) states that there is a need for a knowledge management model in rural areas that will manage all knowledge systems in order to improve farming activities.

Web 2.0 technologies play a big role in the modern era as it facilitates the exchange of information (Chisita, 2012). According to Ballantyne (2010), blogs and wikis are examples of innovative systems that offer a wide variety of knowledge sharing opportunities. A simpler electronic tool is a telephone hotline which farmers can call to leave messages or talk directly to a professional who can answer their questions immediately (Queensland Government, 2011). Chisita (2012) states that mobile technologies are replacing the traditional information source by facilitating access to agricultural information. A mobile application could then be seen as a viable electronic tool for agricultural knowledge management and will be discussed in the next section.

3.3 Mobile application for agricultural knowledge management

A mobile application is a software application that is designed to run on mobile devices such as smart phones and tablets (Inukollu *et al.*, 2014). According to Flood (2012), mobile applications provide the user with portability and convenience. Agricultural activities strive towards higher productivity which requires an “information-based decision-making agricultural system” (Brugger, 2011). The mobile application design should be informative and user friendly as it is aimed at a rural community. In order to achieve this, the field of human-computer interaction and human-computer interaction principles should be examined.

3.4 Human-Computer Interaction

Human-Computer Interaction is the study of the design, implementation and evaluation of how people interact with computing devices (Kim, 2015:1). Parmar (2008) states that HCI focuses on both the machine and the human. He further elaborates that HCI is concerned with the communication and joint performance of both the computing device and the person.

Fallman (2003) regards HCI as a design oriented field. He further elaborates that design is defined as creating a non-existent artefact. According to Kendall and Kendall (2011:441), the primary goal of HCI is to achieve individual and organisational user effectiveness and efficiency of use. In order to effectively achieve this, different principles within the HCI field should be investigated.

3.4.1 HCI principles

HCI principles are also known as design rules that are centred on the theories of how people interact with computing devices (Dix *et al.*, 2004:259; Te’eni *et al.*, 2007:14). HCI principles can thus be regarded as design rules that assist the researcher in the design of an artefact.

The following are examples of general HCI principles:

- *Predictability*

Dix *et al.* (2004:261) define predictability as the ability of the user to determine the effect of a future action based on actions in the past. Predictability is a user centric principle concept (Hinze-Hoare, 2007). This principle allows the user to perform an action and be confident of the expected outcome of that action. Figure 3.1 depicts a scenario in which the user is expected to predict the outcome.



The user knows from past experiences that the red box with a cross in it means the program will terminate.

Figure 3.1: The principle of predictability illustrated in the title bar of Mozilla Firefox.

- *Consistency*

Consistency relates to the similarities between objects or events (Dix *et al.*, 2004:264). Kendall and Kendall (2011:461) explain that consistency allows users to easily learn new aspects of an interactive system. Consistency can thus be defined as the likeness between similar objects. Figure 3.2 and Figure 3.3 depict the principle of consistency as the main theme, structure and aesthetic appeal remains the same throughout the design.

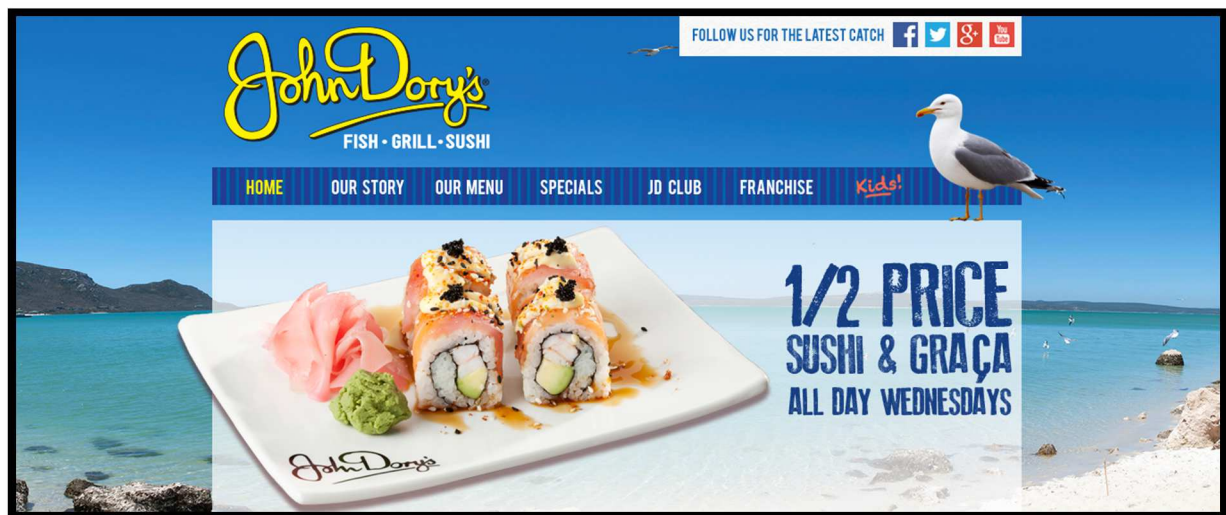


Figure 3.2: The principle of consistency illustrated in John Dory's Home page (<http://www.johndorys.co.za/>).

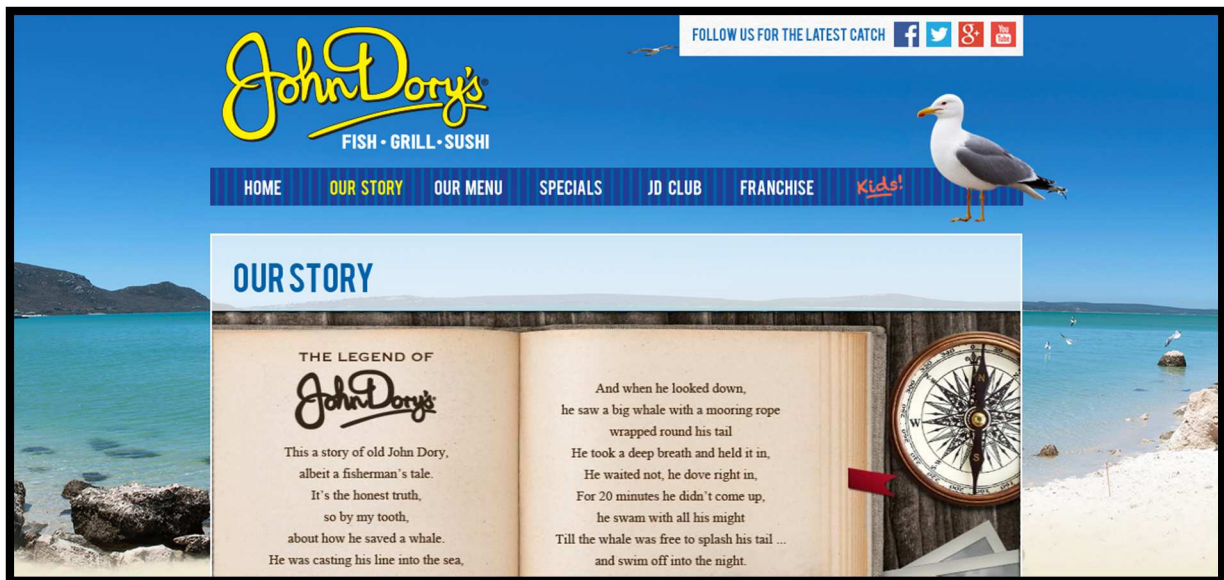
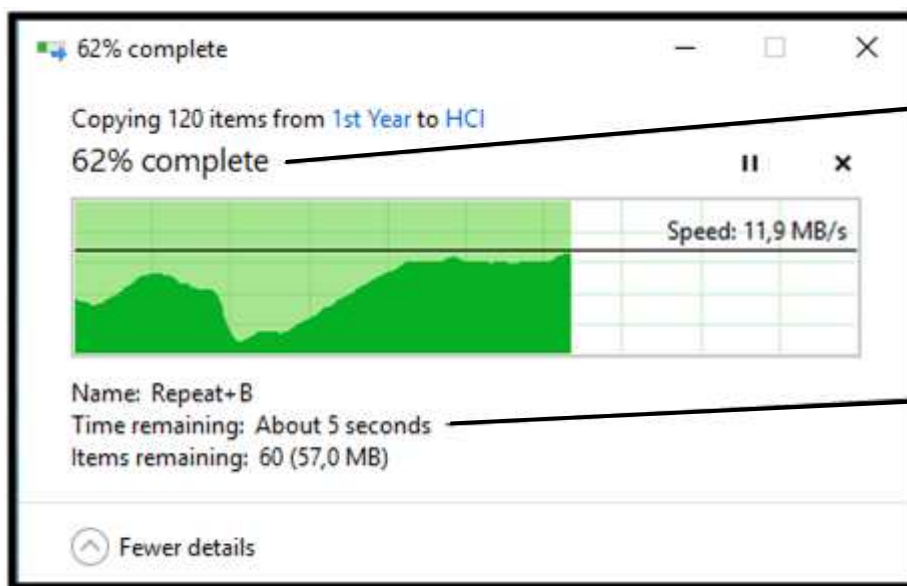


Figure 3.3: The principle of consistency continued on John Dory's Our Story page (<http://www.johndorys.co.za/our-story>).

- *Feedback*

Feedback can be seen as an action taken to remind the user of a certain task or simply to refresh the users' memory (Kim, 2015:8). Galitz (2002:543) explains that communication within an interactive system should be clear and simple to understand and it must politely provide the relevant information. The progress bar in Figure 3.4 clearly informs the user as to how far the transferal of information is and how much time is still needed to complete the action.



The system clearly informs the user of the progress of the task.

The system clearly informs the user of the time required to complete the task.

Figure 3.4: The principle of feedback shown through a Windows 10 progress bar for transferring files.

- *Dialog Initiative*

Dialog initiative can be defined as the freedom the user experiences from input dialog constraints imposed by the system (Kellar, 2016). Dix *et al.* (2004:266) state that within the principle of dialog initiate, it is important to determine which partner has the conversation initiative. They further elaborate on the two types of dialog namely, system pre-emptive or user pre-emptive. Figure 3.5 shows a system pre-emptive dialog.

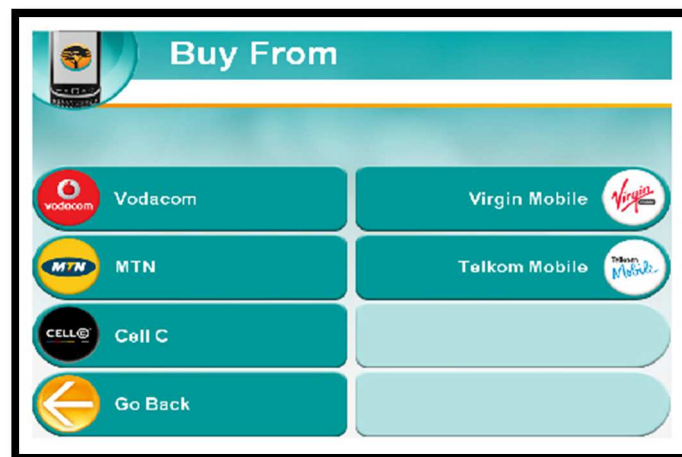


Figure 3.5: The principle of dialog initiative illustrated through the system pre-emptive dialog of FNB's Asynchronous Transfer Mode (ATM) screen to purchase airtime (https://www.fnb.co.za/03images/pages/howToDemos/atm-cellphone-prepaid/banner_6.jpg).

- *Recoverability*

Hinze-Hoare (2007) defines the principle of recoverability as the ability to recover after the recognition of an error. There are two types of recovery namely: forward error recovery and backward error recovery (Dix *et al.*, 2004:272). Figure 3.6 shows the ability of a file to be restored, also known as backward error recovery.

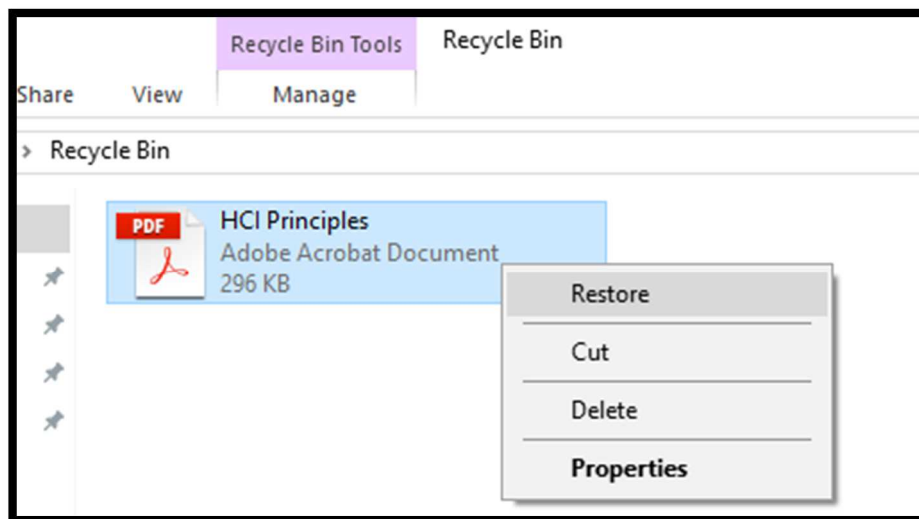


Figure 3.6: The principle of recoverability demonstrated through backward error recovery when a folder can be restored from the recycle bin after accidental deletion.

The field of HCI and HCI principles have briefly been introduced and explained. In the next section, the HCI principles appropriate for an agricultural mobile application is identified.

3.5 HCI principles for mobile application design

The study is aimed at designing an agricultural mobile application that will be used by a rural community by determining which HCI principles are appropriate. According to Hoekman (2010:242), consistency in application design is vital as it allows the user to understand the application. He further states that system feedback is what makes an application exceptional (Hoekman, 2010:14).

As the user will be communicating with the system through a series of existing dialogs, the principle of dialog initiative is applicable. This also implies that there is a small margin for error and thus the principle of recoverability is not relevant to this study.

The user will need to know what they are doing when using the artefact. This means the principle of feedback is required. In addition to this principle, the principle of consistency is required in the design of this artefact as it will allow the user to comprehend the artefact more easily. Due to the limited scope of the artefact, the principle of predictability was eliminated.

Thus, the HCI principles relevant to the design of an agricultural mobile application are consistency, dialog initiative and feedback.

According to Pearson *et al.*, (2010), consistency in design is of vital importance as poor consistency could lead to bad interactions or poor usage. Design consistency is key to a usable interface (Mandel, 1997). Gong and Tarasewich (2004) state that consistency in mobile application design is of greater importance compared to other design rules as users may need to switch between computing devices. This means that the principle of consistency with regards to mobile application design will create a sense of familiarity and further expand the principle of learnability. Figure 3.7 contains two screenshots of a mobile application that has applied the principle of consistency. The design of the application enables the user to become familiar with it.

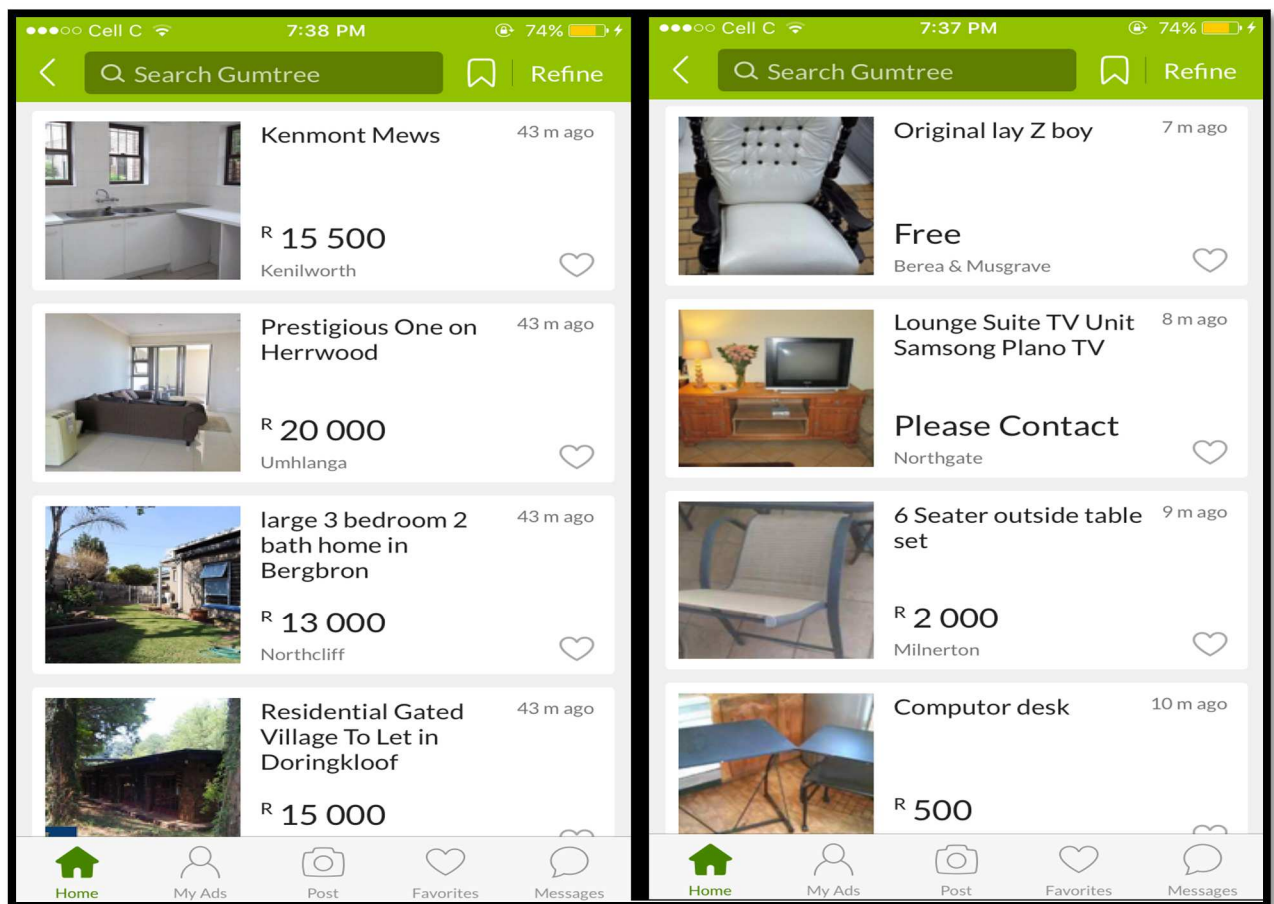


Figure 3.7: Gumtree mobile application displaying the principle of consistency.

The principle of dialog initiative gives the user a sense of accomplishment or involvement (Gong & Tarasewich, 2004). Kendall and Kendall (2011:554) emphasise that a good dialog design enables easier communication between people and computers. The principle of dialog initiative in mobile applications is essential as people are constantly using their mobile devices. Figure 3.8 illustrates the principle of dialog initiative as the system has given the user a choice of three action paths. This dialog is known as system pre-emptive dialog as the system initiates the dialog.

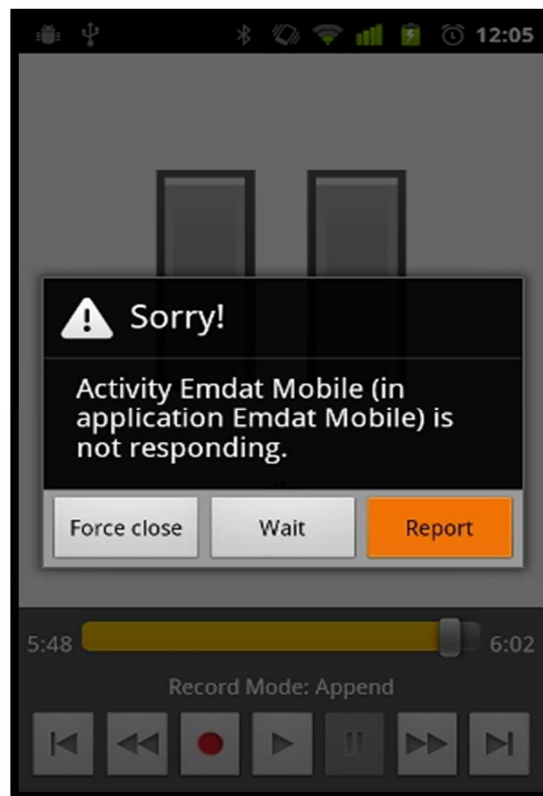


Figure 3.8: Emdat Mobile application displaying the principle of dialog initiative.

Feedback within the user interface is of great value to the users (Mandel, 1997). According to Kendall and Kendall (2011:556), the principle of feedback is required by all systems as it monitors and changes the behaviour of the system. Mobile application feedback could be in the form of an alert or a confirmation (Stark, 2012). The principle of feedback is critical to the design of a mobile application as it allows the user to know what is happening during performance. Figure 3.9 displays an instance where feedback from the mobile application is given. In this scenario, without the system feedback, the user would assume that the mobile application has stopped functioning as it is not providing the necessary outcome.

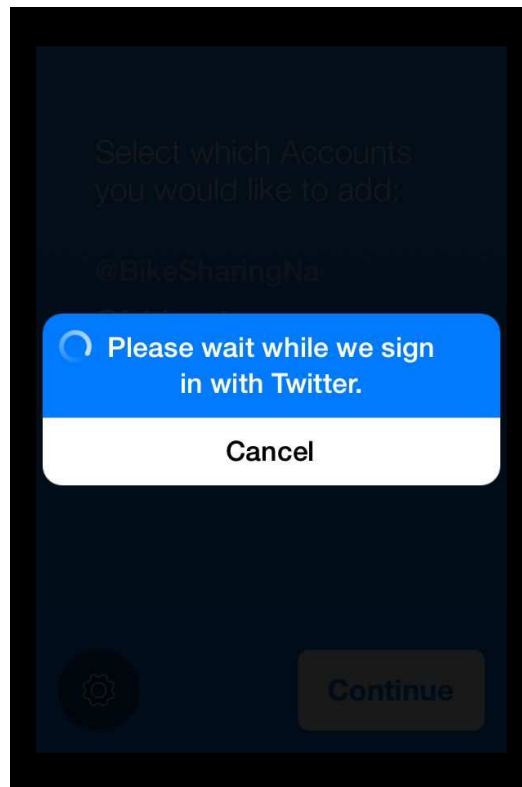


Figure 3.9: Twitter mobile application displaying the principle of feedback.

According to Gong and Tarasewich (2004), consistency and informative feedback can be seen as guidelines for mobile application design. Seeing as the interaction between the system and user is known as the dialog, it is important to determine who has the initiative of the dialog (Dix *et al.*, 2004:266). The selected HCI principles that may be appropriate for the design of an agricultural mobile application are consistency, dialog initiative and feedback.

3.6 Conclusion

The focus on this chapter was to gain insight into the fields of mobile applications, HCI and HCI principles. This was achieved by analysing existing bodies of work. HCI principles were introduced and explored with regards to mobile application design. The applicable HCI principles were identified and explained.

In the next chapter the data collection methods are explained and the collected data is analysed.

CHAPTER 4: DATA ANALYSIS

4.1 Introduction

The goal of this study is to design an agricultural mobile application for a rural community by determining which HCI principles are appropriate design guidelines. This chapter focuses on the second section of the suggestion phase.

The purpose of conducting interviews is to gain a better insight and understanding into the requirements required to design an agricultural mobile application. Written interviews were conducted with participants as part of the requirements analysis for the design of the artefact.

This chapter starts with an explanation of the participants as well as the written interview questions (Section 4.2). Section 4.3 provides the feedback obtained from the interviewees. The analysis of the obtained data is elaborated upon in Section 4.4. The chapter ends with the conclusion found in Section 4.5.

4.2 Participants and the interview questions

The participants applicable to the study are specialists in the fields of mobile application and HCI. Feedback obtained from mobile application specialists will be beneficial towards the design of the artefact as they have designed and developed various functioning mobile applications and they have dealt with the client's needs and expectations. HCI specialists are capable of identifying HCI principles within the design of a project of any nature. Feedback gathered from these specialists will be constructive towards the design of the agricultural mobile application.

As the nature of the scope is limited, written interviews were conducted with three participants as the saturation of the interpretive information required was achieved.

Table 4.1 below contains the interview question that will be used in data gathering. These interview questions were found in different literature sources.

Table 4.1: Interview questions for a mobile application.

Number	Question
1.	What do you want your site to accomplish? (Board, 2013)
2.	What is the user journey and experience? (McLandress, 2015)
3.	Are there any colour preferences for the new website? (Gill, 2013)
4.	Name the three things that are most important in the design of your new website? (deGeyter, 2014)

5.	What functional requirements are needed within the new websites? (Gill, 2013)
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The questions from Table 4.1 were tailored for the purpose of this study. The adapted questions are depicted below in Table 4.2.

Table 4.2: Adapted interview questions for an agricultural mobile application.

Number	Question from source	Modified question for the study
1.	What do you want your site to accomplish? (Board, 2013)	What should an agricultural mobile application accomplish?
2.	What is the user journey and experience? (McLandress, 2015)	What should the user experience be for an agricultural mobile application?
3.	Are there any colour preferences for the new website? (Gill, 2013)	Are there any colour preferences for an agricultural mobile application?
4.	Name the three things that are most important in the design of your new website? (deGeyter, 2014)	Name the three things that are most important in the design of an agricultural mobile application.
5.	What functional requirements are needed within the new websites? (Gill, 2013)	What functional requirements (e.g. interface, security, functions etc.) are required within an agricultural mobile application?

The feedback gathered from participants are presented in the next section.

4.3 Feedback obtained from the interview

Written interviews were conducted with participants and their feedback was documented. The participant's feedback can be found in Table 4.3 below.

Table 4.3: Feedback gathered from participants.

Number	Modified question for the study	Participant 1	Participant 2	Participant 3	Participant 4
1.	What should an agricultural mobile application accomplish?	<ul style="list-style-type: none"> • It should be able to detect your location, in order to tell you which crops is best suited for your location. • It should remind you when to water your crops. • It should be able to identify the different plant diseases and show you how to treat them. • Should help you identify insects or birds that might influence your crops. 	<ul style="list-style-type: none"> • An agricultural app should allow users to record their own information regarding the crops that they have planted. Sort of a diary / calendar function where the user can take photos and make audio or text notes to record the progress of the crops. • It could include a weather forecasting section as well. 	<ul style="list-style-type: none"> • It must be used off line as well as online (updates) considering the areas in which the users work. 	<ul style="list-style-type: none"> • An agricultural app should allow the user to access information about which crops grow best during which time of year. • It should also advise on the planting process - what type of sunlight, soil and conditions are required for maximum return. • It can also provide additional information about the type of plant - characteristics for identification,

		<ul style="list-style-type: none"> • It should tell you when, where and how to plant a crop. 	<ul style="list-style-type: none"> • All of these functions will help to give a personalised experience for the user. 		<p>medicinal properties, nutritional values etc.</p> <ul style="list-style-type: none"> • Images should be added of the plant and the seed so that it can easily be identified.
2.	What should the user experience be for an agricultural mobile application?	<ul style="list-style-type: none"> • It should be simple and easy to use with the least amount of wording. Most buttons should rather have pictures describing their functions. 	<ul style="list-style-type: none"> • It must be easy for the user to learn how to use the app. • This can be accomplished by for example creating certain functions to work in the same way as similar functions in other apps. • For example if the agriculture app allows searching through different 	<ul style="list-style-type: none"> • Easy to use interface with simple graphics and common used phrases. 	<ul style="list-style-type: none"> • It should be easy to use and easy to understand with a logical flow of operations. • The navigation process should be consistent for all options.

			plants, the search functionality should work similar to the search function of other apps.		
3.	Are there any colour preferences for an agricultural mobile application?	<ul style="list-style-type: none"> • It should have bright colours rather than brown dead colours that might discourage users and make them doubt their planting skills. • Bright colours might include pictures of fresh tomatoes, lettuce, etc. 	<ul style="list-style-type: none"> • We usually associate agriculture with green or brown colours, but these colours might not be effective for a user who is colour blind for example. • A possible solution would be to allow the user to select their own colour scheme. 	<ul style="list-style-type: none"> • Pastel colours (blue, green, brown) etc. 	<ul style="list-style-type: none"> • Colour choices should match the expectation of the user i.e. agriculture is associate with green and brown. • Images of the plants and seeds should be accurate to the real plant and seed.
4.	Name the three things that are most important in the design of an	<ul style="list-style-type: none"> • Simple layout and easy to use. 	<ul style="list-style-type: none"> • The app must be functional, that is, it must do what it is 	<ul style="list-style-type: none"> • Consistency throughout the app. • Correct information for the user. 	<ul style="list-style-type: none"> • Easy to understand and use (principle of familiarity and predictability).

	agricultural mobile application?	<ul style="list-style-type: none"> • Stick to the same look throughout the whole application. • Keep wording as simple as possible. 	<p>supposed to do and do it correctly.</p> <ul style="list-style-type: none"> • The app must be easy to use. • The app must be appealing to the user. 	<ul style="list-style-type: none"> • User friendly. 	<ul style="list-style-type: none"> • The design of the navigation process should be constant for all options (principle of consistency). • The design should meet the expectation of the user i.e. accomplish the task it promises (principle of task conformance).
5.	What functional requirements (e.g. interface, security, functions etc.) are required within an agricultural mobile application?	<ul style="list-style-type: none"> • Provide a platform where you can connect with other user to discuss progress or problems with others. • Should determine your current location. • Should record statistics such as 	<ul style="list-style-type: none"> • Location services might be important to provide the user with which crops to plant and for providing relevant real-time weather forecasts and updates. 	<ul style="list-style-type: none"> • Have a platform whereby the community can share their ideas and views. • Online - have a weather alert to inform the farmers of a storm, rain or hail conditions. 	<ul style="list-style-type: none"> • If the app is location specific it should be able to access Google location services - the app can then have built in features to provide the user with a recommended lists

		<p>success rate, total output per square meter etc.</p> <ul style="list-style-type: none"> • Access weather data. 	<ul style="list-style-type: none"> • The app could provide sharing functions so that users in the same area can share the progress of their crops and to exchange knowledge and tips regarding the crops. • This would require internet connectivity and online storage. 		<p>of plants appropriate for the area.</p> <ul style="list-style-type: none"> • If the app allows user input/searches it should provide feedback in real-time. • If the app allows stored information for the user e.g. preferred plants, progress reports on growth of current plants etc. - it should have access to a local or online database in order to store specific information.
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4.4 Analysis of data obtained from the written interviews

The data analysis technique used in this study is open coding which is a process for content analysis. According to Khandkar (2009), open coding is a qualitative data analysis technique that involves analysing the data in order to create categories based on their similarities and differences. The feedback obtained from question 1 'what should an agricultural mobile application accomplish' is recorded in Table 4.4.

Table 4.4: Feedback gathered from question 1.

What should an agricultural mobile application accomplish?	
Code assigned	Example answers
Access to factual information (2 occurrences)	"It should be able to identify the different plant diseases and show you how to treat them."
	"An agricultural app should allow the user to access information about which crops grow best during which time of year."
Factual plant requirements (2 occurrences)	"It should remind you when to water your crops."
	"It should also advise on the planting process - what type of sunlight, soil and conditions are required for maximum return."
	"Images should be added of the plant and the seed so that it can easily be identified."
Personalised experience (2 occurrences)	"All of these functions will help to give a personalised experience for the user."
	"It must be used off line as well as online (updates) considering the areas in which the users work."

From Table 4.4 above, we can gather that an agricultural mobile application should provide access to agricultural information and plant requirements. The agricultural mobile application should also provide a personalised experience.

The responses gathered for question 2, what the user experience should be for an agricultural mobile application, is depicted in Table 4.5.

Table 4.5: Feedback gathered from question 2.

What should the user experience be for an agricultural mobile application?	
Code assigned	Example answers
Easy to use (4 occurrences)	"It should be simple and easy to use with the least amount of wording."
	"It must be easy for the user to learn how to use the app."
	"Easy to use interface with simple graphics and common used phrases."
	"It should be easy to use and easy to understand with a logical flow of operations."
Predictability (4 occurrences)	"It should be simple and easy to use with the least amount of wording."
	"This can be accomplished by for example creating certain functions to work in the same way as similar functions in other apps."
	"Easy to use interface with simple graphics and common used phrases."
	"The navigation process should be consistent for all options."
Graphical display (2 occurrences)	"Most buttons should rather have pictures describing their functions."
	"Easy to use interface with simple graphics and common used phrases."

Table 4.5 depicts the responses gathered for question 2. According to the participants, ease of use, predictability and a graphical display of certain functions are what users should experience when using an agricultural mobile application.

Table 4.6 below depicts the feedback for question 3 regarding the colour preferences of an agricultural mobile application.

Table 4.6: Feedback gathered from question 3.

Are there any colour preferences for an agricultural mobile application?	
Code assigned	Example answers
Use of pictures (2 occurrences)	"Bright colours might include pictures of fresh tomatoes, lettuce, etc."

	"Images of the plants and seeds should be accurate to the real plant and seed."
Use of agricultural colours (3 occurrences)	"We usually associate agriculture with green or brown colours."
	"Pastel colours (blue, green, brown) etc."
	"Colour choices should match the expectation of the user i.e. agriculture is associate with green and brown."

According to Table 4.6, the colour preferences for an agricultural mobile application are agricultural colours such as green and brown. It is also suggested that accurate pictures of agriculture related object be used.

The three most important aspects in the design of an agricultural application, according to the feedback obtained for question 4, is recorded in Table 4.7.

Table 4.7: Feedback gathered from question 4.

Name the three things that are most important in the design of an agricultural mobile application.	
Code assigned	Example answers
Easy to use (4 occurrences)	"Simple layout and easy to use."
	"The app must be easy to use."
	"User friendly."
	"Easy to understand and use (principle of familiarity and predictability)."
Factual (2 occurrences)	"The app must be functional, that is, it must do what it is supposed to do and do it correctly."
	"Correct information for the user."
Consistent (3 occurrences)	"Stick to the same look throughout the whole application."
	"Consistency throughout the app."
	"The design of the navigation process should be constant for all options (principle of consistency)."

Table 4.7 above suggests that the three most important aspects in the design of an agricultural mobile application are ease of use, factuality and consistency.

Table 4.8 portrays the feedback for question 5 pertaining to what functional requirements are required within an agricultural mobile application.

Table 4.8: Feedback gathered from question 5.

What functional requirements (e.g. interface, security, functions etc.) are required within an agricultural mobile application?	
Code assigned	Example answers
Location services (4 occurrences)	“Should determine your current location.”
	“Location services might be important to provide the user with which crops to plant and for providing relevant real-time weather forecasts and updates.”
	“Online - have a weather alert to inform the farmers of a storm, rain or hail conditions.”
	“If the app is location specific it should be able to access Google location services.”
Planting recommendations (2 occurrences)	“The app could provide sharing functions so that users in the same area can share the progress of their crops and to exchange knowledge and tips regarding the crops.”
	“The app can then have built in features to provide the user with a recommended lists of plants appropriate for the area.”

According to the feedback gathered in Table 4.8, location services and access to online agricultural databases are functional requirements that are required within an agricultural mobile application.

4.5 Conclusion

The focus on this chapter was to analyse the gathered data. This was achieved by using open coding. The data was broken down into categories. Table 4.9 depicts the most popular requirements for the design of an agricultural mobile application.

Table 4.9: Most important requirements according to analysed data.

Most important requirements in the design of an agricultural mobile application.	
1.	Easy to use.

2.	Access to factual agricultural information.
3.	Access to factual plant requirements.
4.	Use of agricultural colours.
5.	Predictability and consistency.

From the information in Table 4.9, we can conclude that the agricultural mobile application should be an easy to use application that provides agricultural information as well as accurate plant requirements. The application should be designed using agricultural colours and needs to be predictable and consistent.

In the next chapter, the artefact is designed and developed according to the identified HCI principles and analysed data.

CHAPTER 5: THE ARTEFACT DESIGN

5.1 Introduction

The goal of this study is to design an agricultural mobile application for a rural community by determining which HCI principles are appropriate design guidelines. This chapter focuses on the development phase of the DSR framework. The development of the agricultural mobile application involves the usage of the HCI principles identified and the participant feedback analysed.

This chapter consists of three sections, namely: summary of principles and feedback (Section 5.2), artefact design in Section 5.3 and the conclusion (Section 5.4).

5.2 Summary of principles and feedback

The design of the agricultural mobile application should satisfy the requirements as set out in the suggestion phase as well as the HCI principles identified. In order to achieve this, the HCI principles should support the participant feedback and vice versa. The relationship between the two is explained below in Table 5.1.

Table 5.1: The link between HCI principles and gathered feedback.

HCI principles	Participant feedback	Explanation
Feedback	Access to factual agricultural information.	Providing factual agricultural information to users creates an artefact that adheres to the principle of feedback.
	Access to factual plant requirements.	Allowing users to access plant requirements provides them with the necessary feedback that allows them to grow plants.
Consistency	Use of agricultural colours.	Using agricultural colours gives users a sense of familiarity. It also allows for design consistency.
	Predictability and consistency.	The user's need for predictability and consistency directly relates with the principle of consistency.
Dialog initiative	Easy to use.	By using system pre-emptive dialog initiative, users will make minimal errors and will provide an easy to use artefact.

The next section visually explains the design of the agricultural mobile application.

5.3 Artefact design

The design of the artefact uses the HCI principles identified and the feedback gathered from participants. This section contains screenshots of the designed artefact using the HCI principles and gathered feedback.

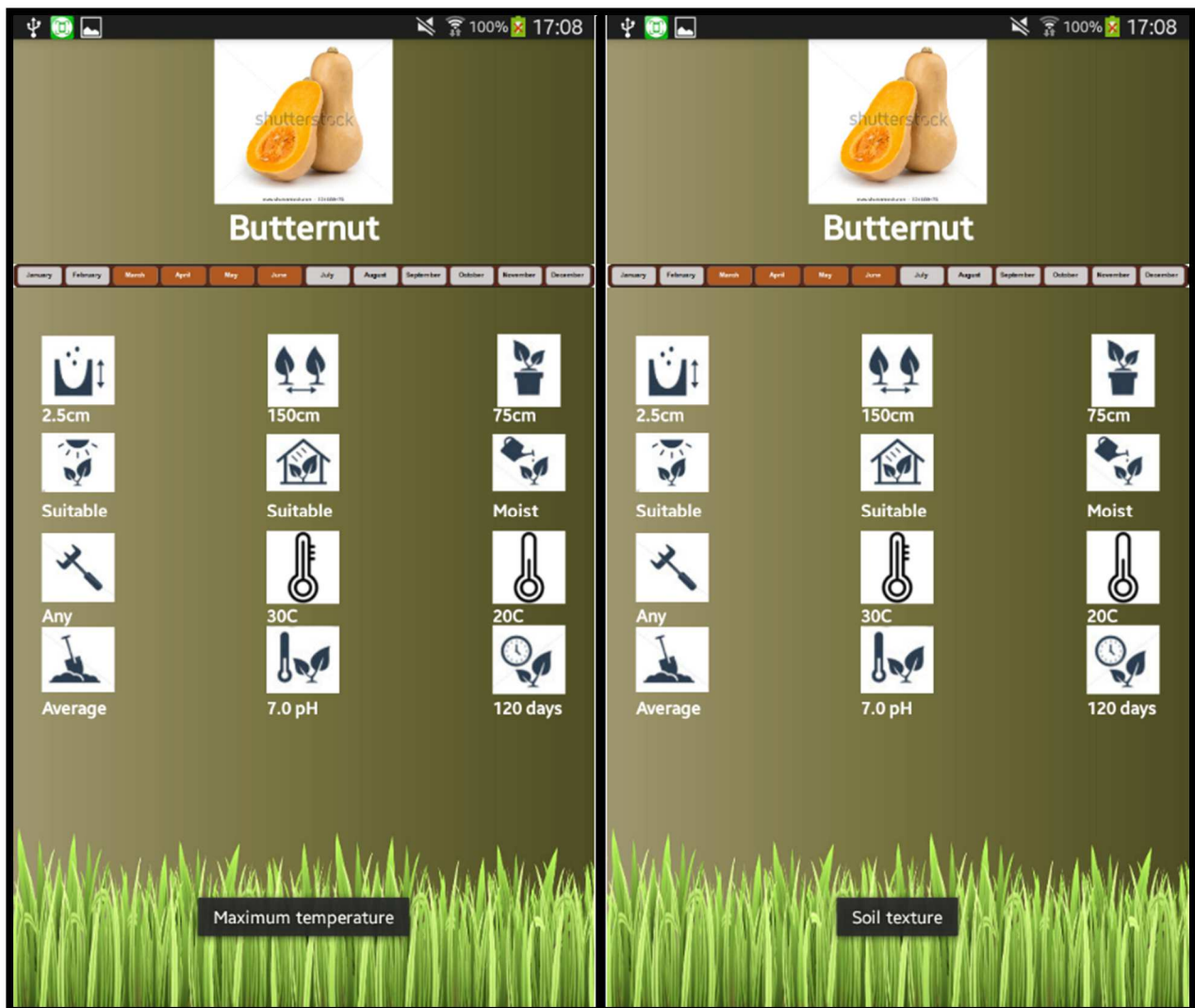


Figure 5.1: Agricultural mobile application illustrating the principle of feedback.

The agricultural mobile application should provide factual information regarding plants. Figure 5.1 above depicts the principle of feedback and how the information is displayed. The use of pictures allows for the app to be used by an illiterate user. If the user were to tap on the given picture, the application would tell the user what the picture means.



Figure 5.2: Agricultural mobile application illustrating the principle of consistency.

Figure 5.2 displays the principle of consistency in the agricultural mobile application. The use of agricultural colours in the design of the agricultural mobile application creates consistency within the application. It also creates a sense of familiarity in the design. Figure 5.2 depicts a consistent theme throughout the various screens.

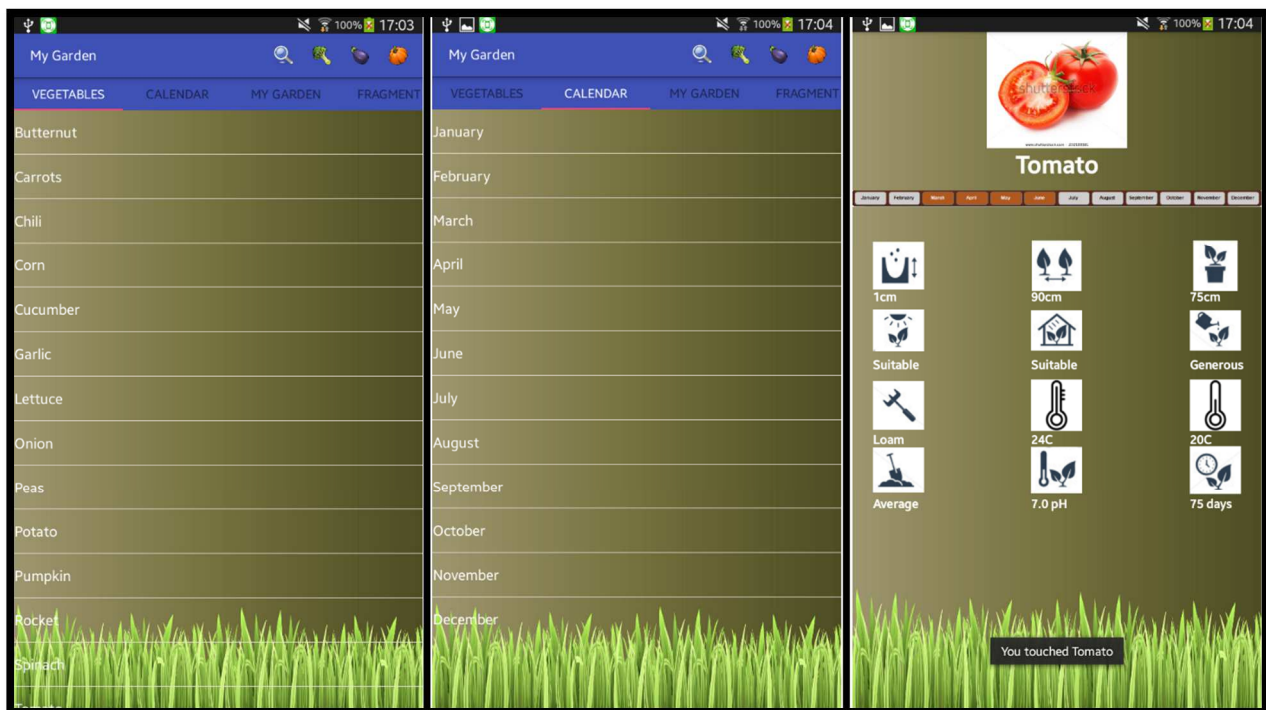


Figure 5.3: Agricultural mobile application illustrating the principle of dialog initiative.

Figure 5.3 above depicts the principle of dialog initiative in the agricultural mobile application. The mobile application is system pre-emptive. This allows for ease of use of the mobile application. There is little room for user error. Every workflow is provided by the system. The first two screens of Figure 5.3 depicts the options that the user is given. One depicts the list of vegetables that the user can choose from, the other depicts a list of the months in a year. If the user were to select a specific month, then a list of all vegetables applicable to that month will be displayed. Once the user has selected the vegetable, the last screen will appear with all the planting requirements.

5.4 Conclusion

This main focus of this chapter was the development phase of the DSR framework. The development of the agricultural mobile application involved the usage of the HCI principles and the participant feedback analysed. The relevant HCI principles were linked to the participant feedback. These HCI principles were then used as requirements analysis for the initial prototype of the artefact. This chapter also included screenshots of the designed mobile application artefact.

The next chapter formally concludes this study.

CHAPTER 6: CONCLUSION

6.1 Introduction

The goal of this study is to design an agricultural mobile application for a rural community by determining which HCI principles are appropriate design guidelines. This chapter is a conclusion to the study.

This chapter begins with a summary of the study in Section 6.2. Limitations and future research is discussed in Section 6.3. Section 6.4 follows with the conclusion of the chapter.

6.2 Summary of study

The research study was comprised of six chapters. It discussed the following:

Chapter 1 – It was established that agricultural communities struggle to keep up with new information regarding cropping. Seeing as mobile application usage has increased year by year, it was suggested that an agricultural mobile application could counter this problem. This chapter served as an introduction to the study. It introduced key concepts to the study. It also dealt with the formulation of primary and secondary objectives.

Chapter 2 – This chapter focussed on the research methodology applicable to the study. It was found that design science research is the most relevant research methodology as this study focusses on the design of an agricultural mobile application. The research process was explained and the design science research framework was introduced. The research objectives were then formulated according to this framework.

Chapter 3 – The focus of this chapter was a literature review. This allowed the researcher to gain insight into the fields of mobile applications, HCI and HCI principles. The relevant HCI principles were identified and explained.

Chapter 4 – This chapter focussed on the analysis of gathered data. Written interviews were used to gather data from participants. The chosen participants were experts in the fields of HCI and mobile application. Open coding was used to analyse the gathered data. Four participants were used as the saturation of information within the scope of the study was achieved. The analysed data formed part of the suggestion phase as a requirements analysis for the artefact.

Chapter 5 – The main focus of this chapter was on the development of the artefact. The design made use of the identified HCI principles and gathered feedback. The HCI principles were linked

with the participant feedback. The relevant HCI principles used in the design of the agricultural mobile applications were: Consistency, feedback and dialog initiative.

Chapter 6 – This chapter focuses on formally concluding the research study. It highlights what each chapter consists of. It also explains any limitations that the study faces as well as future research.

6.3 Limitations and future research

The scope and nature of this research study was limited as it only forms part of an Honours project. Due to this, some aspects of the research was excluded and can be suggested for future research:

- The HCI principles used in the design of the agricultural mobile application was limited to three principles. A wider scope would have allowed for the integration of more HCI principles thus improving the design of the artefact.
- Four participants were used to gather information from whereas a wider scope would allow for more participants to give insight into the design of the artefact.
- Written interviews were the only data analysis technique used. It could have been beneficial to use more than one technique at various stages to ensure continuous improvement on the design of the artefact.

6.4 Conclusion

Generational knowledge within the agricultural community is not being passed down to..... New and developing farmers are not able to access the generational knowledge. Seeing as mobile application usage has increased, it was suggested that an agricultural mobile application would assist in providing agricultural knowledge to these communities. Knowledge management in agriculture allows farmers to access agricultural knowledge and yield value from the knowledge resources

The goal of this study was to design an agricultural mobile application for a rural community by determining which HCI principles are appropriate design guidelines. The mobile application can be used in farming communities' decision making process. The theoretical concepts applicable to this study were: human-computer interaction, HCI principles, design science research, mobile applications and knowledge management in agriculture. The research problem was introduced and discussed and the research objectives were formulated.

The research methodology applicable to this study was design science research as the study was focussed on the design of an artefact. The DSR methodology was used to establish a framework

from which the research process was constructed. A literature review was established in order to gain insight into the fields of HCI and mobile applications. The HCI principles were then identified and refined to three relevant principles, namely: feedback, consistency and dialog initiative. Feedback was then gathered from participants using written interviews. The feedback was then analysed using open coding. The results were then used along with the relevant HCI principles to design the agricultural mobile application.

The goal of this study was achieved through the presentation of a design for an agricultural mobile application using HCI principles. The artefact addressed the research problem identified by possibly acting as a knowledge management system for agricultural knowledge that could be used by a rural community.

REFERENCES

- Ballantyne, P. 2010. Agricultural information and knowledge sharing: Promising opportunities for agricultural information specialists [Article and Abstract]. *Agricultural Information Worldwide*, 3(1):4-9.
- Baskerville, R. 2008. What design is not. *European Journal of Information Systems*, 17(5): 441-443.
- Beal, V. 2016. HCI – human-computer interaction.
<http://www.webopedia.com/TERM/H/HCI.html> Date of access: 21 February 2016.
- Board, B. 2013. The 10 questions you MUST ask your client before designing their website.
<http://blog.web123partners.com.au/blog/the-10-questions-you-must-ask-your-client-before-designing-their-website.aspx> Date of access: 11 June 2016.
- Brugger, F. 2011. Mobile applications in agriculture. Basel: Syngenta Foundation.
- BusinessDictionary.com. 2016. Objectives.
<http://www.businessdictionary.com/definition/objective.html> Date of access: 08 April 2016.
- Campbell, J.K. 1990. Dibble sticks, donkeys, and diesels: machines in crop production. Philippines: International Rice Research Institute.
- Chisita, C.T. 2012. Knotting and networking agricultural information services through Web 2.0 to create an informed farming community: a case of Zimbabwe. Paper presented at the *International Federation of Library Associations and Institutions*.
- Cohen, D. & Crabtree, B. 2006. Qualitative research guidelines project.
<http://www.qualres.org/HomePosi-3515.html> Date of access: 07 April 2016.
- Cohen, D & Crabtree B. 2006. Qualitative research guidelines project.
<http://www.qualres.org/HomeInte-3516.html> Date of access: 07 April 2016.
- Corbin, J.M. & Strauss, A. 1990. Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology*, 13(1):3-21.
- Costopoulou, C., Manouselis, N., Ntaliani, M., Palavitsinis, N. & Tzikopoulos, A. 2010. Training agricultural tutors in digital learning repositories. *METASCHOOL*: 27.

deGeyter, S. 2014. 100+ questions you must ask when developing a website.
<http://marketingland.com/100-questions-you-must-ask-when-developing-web-site-86342> Date of access: 11 June 2016.

Department of Agriculture, Forestry and Fisheries. 2015. Economic review of the South African agriculture.
http://www.senwes.co.za/Files/main_products/services/agriservices/2015/EconomicReview2014.pdf Date of access: 22 May 2016.

Dix, A., Finlay, J., Abowd, G.D. & Beale, R. 2004. Human-Computer Interaction. 3rd ed.
England: Pearson Education.

Dix, A. 2009. Human-computer interaction. Encyclopedia of Database Systems. Boston, MA, Springer US: 1327-1331.

Driscoll, D.L. & Brizee, A. 2012. Ethical considerations in primary research.
<https://owl.english.purdue.edu/owl/resource/559/02/> Date of access: 21 February 2016.

Fallman, D. 2003. Design-oriented human-computer interaction. Paper presented at the Proceedings of the *SIGCHI conference on Human factors in computing systems*, Florida.

Fink, A. 2014. Conducting research literature reviews: From the internet to paper. 4th ed.
California: Sage Publications.

Flood, D., Harrison, R., Iacob, C. and Duce, D. 2012. Evaluating mobile applications: A spreadsheet case study. *International Journal of Mobile Human Computer Interaction*, 4(4): 37-65.

Galitz, W.O. 2002. The essential guide to user interface design: An introduction to GUI design principles and techniques. 2nd ed. New York: John Wiley & Sons, Inc.

Gill, R. 2013. Successful web design projects: 50+ questions to ask before you start.
<https://www.web-savvy-marketing.com/2013/03/web-design-projects-50-questions/> Date of access: 11 June 2016.

Gong, J. & Tarasewich, P. 2004. Guidelines for handheld mobile device interface design. In. Proceedings of *DSI 2004 Annual Meeting organised by*. p. 3751-3756.

Gregor, S. & Hevner, A.R. 2013. Positioning and presenting design science research maximum impact. *MIS Quarterly*, 37(2): 337-356.

Hevner, A.R. & Chatterjee, S. 2010. Design research in information systems. New

York: Springer Science+Business Media.

Hevner, A.R., March, S.T., Park, J. & Ram, S. 2004. Design science in information systems research. *MIS Quarterly*, 28(1):75-105.

Hinze-Hoare, V. 2007. Review and analysis of human computer interaction (HCI) principles. <https://arxiv.org/ftp/arxiv/papers/0707/0707.3638.pdf> Date of access: 23 April 2016.

Hoekman, R. 2010. Designing the obvious: A common sense approach to web & mobile application design. 2nd ed. Berkeley: Pearson Education.

Inukollu, V.N., Keshamoni, D.D., Kang, T. & Inukollu, M. 2014. Factors influencing quality of mobile apps: Role of mobile app development life cycle. *International Journal of Software Engineering & Applications* 5(5):15-34.

Khandkar, S.H. 2009. Open coding. *University of Calgary*, 23.

Kellar, S.A. 2016. Usability and human-computer interaction: A concise study. Delhi: PHI Learning.

Kendall, K.E. & Kendall, J.E. 2011. Systems analysis and design. 8th ed. Upper Saddle River, NJ: Prentice Hall.

Kim, G.J. 2015. Human-computer interaction: Fundamentals and practice. Boca Raton, FL: CRC Press.

King, D. & Kimble, C. 2004. Uncovering the epistemological and ontological assumptions of software designers. *arXiv preprint cs/0406022*.

Koenig, M.E.D. 2012. What is KM? Knowledge management explained. <http://www.kmworld.com/Articles/Editorial/What-Is-.../What-is-KM-Knowledge-Management-Explained-82405.aspx> Date of access: 29 July 2016.

Kothari, C.R. 2004. Research methodology methods & techniques. 2nd ed. New Delhi: New Age International Publishers.

Lwoga, E.T. 2011. Knowledge management approaches in managing agricultural indigenous and exogenous knowledge in Tanzania. *Journal of Documentation*, 67(3):407-430.

MacDonald, S. & Headlam, N. 2008. Research methods handbook: Introductory guide to research methods for social research. Manchester: CLES.

Mack, L. 2010. The philosophical underpinnings of education research. *Polyglossia*, 19.

- Maltz, A. 2012. The art of farming: cultivating innovative local knowledge. *Transformations*, 23(2):61.
- Marsh, E.E. & White, M.D. 2006. Content analysis: A flexible methodology. *Library trends*, 55(1):22-45.
- Mandel, T. 1997. The elements of user interface design. <http://theomandel.com/wp-content/uploads/2012/07/Mandel-GoldenRules.pdf> Date of access: 27 April 2016.
- McGregor, S.L.T. & Murnane, J. A. 2010. Paradigm, methodology and method: Intellectual integrity in consumer scholarship. *International journal of Consumer Studies*, 34(4): 419-427.
- McLandress, K. 2015. 5 must-ask questions before designing a mobile app. <http://blog.apps-builder.com/questions-before-designing-mobile-app/> Date of access: 11 June 2016.
- Miguel de Benavides Library. 2008. The research process. <http://library.ust.edu.ph/pages/research.html> Date of access: 03 April 2016.
- Montecuolo, M. 2011. Selecting the right approach for your App. <http://door3.com/insights/selecting-right-approach-your-mobile-app#.Vy9g575HXR4> Date of access: 22 February 2016.
- Mtega, W.P., Dulle, F.W., Malekani, A.W. and Chailla, A.M. 2014. Awareness and use of Web 2.0 technologies in sharing of agricultural knowledge in Tanzania. *Knowledge Management & E-Learning: An International Journal (KM&EL)*, 6(2):188-202.
- New English Usage Dictionary. 1996. 3rd ed. Randburg: Hodder & Stoughton Educational.
- Oates, B.J. 2006. Researching information systems and computing. Los Angeles: SAGE Publications.
- Parmer, D. 2008. Human-computer interaction. <http://sit.iitkgp.ernet.in/research/aut04seminar1/5r.pdf> Date of access: 23 April 2016.
- Pearson, J., Buchanan, G. & Thimbleby, H. 2010. HCI design principles for ereaders. In. *Proceedings of the third workshop on Research advances in large digital book repositories and complementary media* organised by: ACM. 15-24.
- Peppers, K., Tuunanen, T., Rothenberger, M.A. & Chatterjee, S. 2007. A design science research methodology for information systems research. *Journal of Management Information Systems*, 24(3): pp.45-77.

Ponterotto, J.G. 2005. Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *Journal of counseling psychology*, 52(2):126.

Queensland Government. 2011. Community engagement guides and factsheets. <http://www.qld.gov.au/web/community-engagement/guides-factsheets/methods-techniques/information-sharing.html> Date of access: 22 April 2016.

Rahmawati, Y. 2008. Epistemological, ontological, and methodological. <https://pendidikansains.wordpress.com/2008/04/12/epistemological-ontological-and-methodological/> Date of access: 07 April 2016.

Rajasekar, S., Philominathan, P. & Chinnathambi, V. 2013. Research methodology. (Unpublished).

Richardson, H. and Robinson, B. 2007. The mysterious case of the missing paradigm: a review of critical information systems research 1991–2001. *Information Systems Journal*, 17(3):251-270.

Ridley, D. 2012. The literature review: A step-by-step guide for students. 2nd ed. London: Sage Publications.

Rogers, Y., Sharp, H. & Preece, J. 2011. Interaction design: Beyond human-computer interaction. New York: Wiley.

Rouse, M. 2013. Mobile app. <http://whatis.techtarget.com/definition/mobile-app> Date of access: 22 February 2016.

Rudolph, S. 2015. Mobile apps usage – Statistics and trends [Infographic]. <http://www.business2community.com/infographics/mobile-apps-usage-statistics-trends-infographic-01248837#gTHWupfiC3Wx9vt7.97> Date of access: 7 February 2016.

Schultze, U. & Avital, M. 2011. Designing interviews to generate rich data for information systems research. *Information and Organization*, 21(1):1-16.

Simon, H.A. 1996. The sciences of artificial. 3rd ed. Cambridge: The MIT Press.

Stark, J. 2012. The 10 principles of mobile interface design. <http://www.creativebloq.com/mobile/10-principles-mobile-interface-design-4122910> Date of access: 27 April 2016.

Statistics South Africa. 2016. Agricultural statistics. http://www.statssa.gov.za/?page_id=735&id=4 Date of access: 19 February 2016.

Smith-Atakan, S. 2006. Human-computer interaction. Cengage Learning EMEA.

SouthAfrica.info. 2012. South African agriculture.

<http://www.southafrica.info/business/economy/sectors/agricultural-sector.htm#.VsboC-aAPAg>

Date of access: 19 February 2016.

Sun, C.H. 2014. Research and design of agricultural information service platform based on cross-platform technology. In. *Applied Mechanics and Materials organised by: Trans Tech Publ.* p. 2731-2735.

Te'eni, D., Carey, J. & Zhang, P. 2007. Human-computer interaction: developing effective organizational information systems. New York: Wiley & Sons.

Vaishnavi, V. & Kuechler, K. 2004. Design research in information systems.

<http://desrist.org/desrist/content/design-science-research-in-information-systems.pdf> Date of

access: 19 February 2016.

Weber, S. 2010. Design science research: paradigm or approach? *Americas Conference on Information Systems 2010 Proceedings*.

Webster, J. & Watson, R.T. 2002. Analyzing the past to prepare for the future: Writing a Literature Review. *MIS quarterly*, 26(2):13-23.

Western Farm Press. 2011. Farmers list top issues impacting agriculture.

<http://westernfarmpress.com/management/farmers-list-top-issues-impacting-agriculture> Date of

access: 11 March 2016.

APPENDIX A – ETHICS LETTER

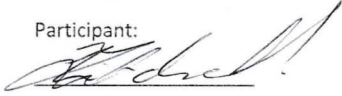
Notice to all participants

Student Chanelle Vermaak 24357936 is currently busy with an honours project where research methods are practiced. He/she identified you as a possible participant in his/her study. Please note the following:

1. The student should advise you on the purpose of the study/ research question.
2. Your participation is voluntary.
3. The student is not conducting research on behalf of the NWU – only gathering data for an assignment.
4. All data will be destroyed after completion of the assignment.
5. Your name will not be published.
6. The student / supervisor may publish his/her findings at a conference.
7. You may at any time ask that your contribution is removed from the study.

Please sign below to indicate that you are aware of the items listed above.

Participant:



Date:

25/09/2016

Thanks for your participation:

Prof Roelien Goede

Module Coordinator: ITR1671

APPENDIX B - SHORT FORM FOR ETHICAL CLEARANCE



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
INSTITUTIONAL OFFICE

Please answer each question by ticking the appropriate box¹:

- | | Yes | No |
|--|-------------------------------------|-------------------------------------|
| 1. Does the study involve participants who are particularly vulnerable ² or unable to give informed consent? (e.g. children, people with learning or other mental or physical disabilities, people who are incarcerated, unemployed or otherwise compromised in responding to your questions) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 2. Are you planning on making use of NWU students or direct and secondary/contracted staff members in this research? | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 3. Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of self-help groups, residents of a nursing home, the Minister of Education, a tribal chief or village elder) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 4. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 5. Will the study involve discussion of or questions about a sensitive topic? (e.g. sexual activity, drug use, crime, harassment, violence) | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 6. Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind or any physical, psychological or socio-economic intervention? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 7. Will blood or tissue samples be obtained from participants? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 8. Could the study induce physical, psychological or social stress or anxiety or cause harm or negative consequences beyond the risks ³ encountered in normal life? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 9. Will the study require the identification of individuals for follow-up evaluation? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 10. Will financial inducements (other than reasonable expenses and compensation for time) or inducements of any other kind be offered to participants? | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 11. I have read the NWU's Manual for Postgraduate Studies and am familiar with the Guidelines for Research Ethics contained therein. | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 12. Could the image of the NWU, the relevant academic department, your employer, or any other institution however affected by/involved in the project be negatively | <input type="checkbox"/> | <input checked="" type="checkbox"/> |

¹ Adapted from Economic and Social Research Council (2005). Research Ethics Framework (REF). www.esrcsocietytoday.ac.uk

² **Vulnerable groups** raise special issues of informed consent and potential risk. "Vulnerable" participants are not clearly described, but have been noted to include "...children, prisoners, pregnant women, mentally disabled persons, economically or educationally disadvantaged persons" (Common Federal Policy, 1991). Weijer and Emanuel (2000) consider participants to be vulnerable if they are not in a position to provide informed consent, due to their position (such as being in prison), or not possessing adequate intellectual faculty (such as children or the mentally ill). "Children" here are defined as participants younger than 18 years of age.

³ **Risk:** These possible risks are described as an "...invasion of privacy, loss of confidentiality, psychological trauma, indirect physical harm, embarrassment, stigma, and group stereotyping" (Oakes, 2002: 449), and also risks posed to "...a subject's personal standing, privacy, personal values and beliefs, their links to family and the wider community, and their position within occupational settings, as well as the adverse effects of revealing information that relates to illegal, sexual or deviant behaviour" (Economic and Social Research Council (ESRC), 2005: 21). Minimal risk may be defined as where "...the probability and magnitude of harm or discomfort anticipated in the proposed research are not greater, in and of themselves, than those ordinarily encountered in daily life" (Code of Federal Regulations, 2005).



affected by this research or put in a bad light?

If you answered **no** to all questions, submit the completed and signed form with your title registration. Students should retain a copy of the form and submit it with their dissertation/thesis.

If you answered **yes** to any of the questions, you will need to describe more fully how you plan to deal with the ethical issues raised by your proposal. **This does not mean that you cannot do the research, only that your proposal will need to be approved by the Research Ethics Committee.** You will need to submit your plans for addressing the ethical issues raised by your proposal using the Ethics Approval Application Form. This may be obtained from: <http://www.nwu.ac.za/library/documents/manualpostgrad.pdf> Alternatively, you may attach a fuller description of the specific issue to this declaration, for discussion by the panel at the Proposal Meeting.

Please note that it is your responsibility to follow NWU's Guidelines for Ethical Research as set out in the Manual for Postgraduate studies and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring the confidentiality in the storage and use of data.** Any significant change in the question, design or conduct over the course of the research should be notified to the Study Leader and may require a new application for ethics approval.

Candidate

Name and Surname:

Chanelle Vermaak

Signature:

Chanelle Vermaak

Supervisor

Name and Surname:

J.I. TERBLANCHE

Signature:

J.I. Terblanche

Chair: Research Proposal Committee:

Name and Surname:

Signature:

Date:

APPENDIX C – ETHICS CLEARANCE DOCUMENT



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS

FACULTY OF ECONOMIC SCIENCES AND INFORMATION TECHNOLOGY

ETHICS CLEARANCE DOCUMENT

Dissertation (M)	
Thesis (PhD)	
Article	
Hons	X

SUPERVISOR				
Study Leader / Promoter / Author(s)	Me J Terblanche			
STUDENT / AUTHOR				
Name	Vermaak C			
Student / Staff Number				
Registered Title of Dissertation or Thesis or Project Title of Article	Designing an agricultural mobile application for a rural community using HCI principles			
School	Accounting		Economics	Information Technology X
ETHICAL CLEARANCE				
Ethics clearance number	ECONIT-2016-127			
Date (of Ethics Sub Committee Meeting)	13 September 2016			

.....
CHAIRPERSON: ETHICS COMMITTEE

19 September 2016 ..
DATE

.....
RESEARCH DIRECTOR

19 September 2016 ..
DATE